Procedure: C-A-AGS-005-MCO
Revision: 04
Revision Date: 02/18/04

COLLIDER-ACCELERATOR DEPARTMENT

Title: Magnet Cleaning Operations EMS Process Assessment

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Group: ESHQ

Approvals

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Collider-Accelerator Department Chairman

(Indicate additional signatures)

Y	N		
[]	x	FS Representative:_______________________________	Date:_______________
[]	x	Radiological Control Coordinator:_______________________________	Date:_______________
[]	x	Chief ME:_______________________________	Date:_______________
[]	x	Chief EE:_______________________________	Date:_______________
[]	x	Environmental/P2 Coordinator:_______________________________	Date:_______________
[]	x	QA Manager:_______________________________	Date:_______________
[]	x	Other:_______________________________	Date:_______________

BROOKHAVEN NATIONAL LABORATORY
PROCESS ASSESSMENT FORM

I. General Information

<table>
<tr><td>Process ID:</td><td colspan="2">AGS-005-MCO</td><td colspan="2">PEP ID # 005</td></tr>
<tr><td>Process Name:</td><td colspan="4">Magnet Cleaning Operations</td></tr>
<tr><td>Process Flow Diagrams:</td><td colspan="4">AGS-005-MCO-01 and 02</td></tr>
<tr><td>Process Description:</td><td colspan="4">This process includes the Magnet Cleaning Operations managed by the Collider-Accelerator (C-A) Department. Magnets are periodically cleaned while in place to remove particulates (scale and/or silt) which build-up in the piping bends and turns of the magnet cooling system. Particulates which build-up within the magnet cooling system can block cooling pipes and cause the magnet to overheat. The three techniques utilized for cleaning fouled or blocked magnets, in the order used, are backwashing, flushing with compressed nitrogen and flushing with an acid solution. Section II and the above-referenced Process Flow Diagrams provide more detail on the Magnet Cleaning Operations.</td></tr>
<tr><td>Dept./Div.:</td><td colspan="4">Collider-Accelerator Department</td></tr>
<tr><td>Dept. Code:</td><td colspan="4">AD</td></tr>
<tr><td>Building(s):</td><td colspan="4">Various</td></tr>
<tr><td>Room(s):</td><td>N/A</td><td></td><td></td><td></td></tr>
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<tr><td>Originally Prepared by:</td><td>D&B, G. Goode</td><td>Original Reviewers:</td><td colspan="2">R. Lee, F. Kobasiuk, P. Stillman, J. Williams</td></tr>
<tr><td>Initial Release Date:</td><td>02/19/99</td><td></td><td colspan="2"></td></tr>
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II. Detailed Process Descriptions and Waste Determination

The Magnet Cleaning Operations managed by the Collider-Accelerator (C-A) Department at Brookhaven National Laboratory (BNL) have been organized into three major processing units, identified as 1.0 through 3.0. Process Flow Diagrams AGS-005-MCO-01 through 02, provided in Attachment 1, graphically depict the process inputs and outputs for the Magnet Cleaning Operations.

Located in the north central portion of BNL, the Collider-Accelerator Department is composed of several accelerator physics machines including the Linac, Tandem Van De Graaff, Booster, Alternating Gradient Synchrotron (AGS), the NASA Space Radiation Facility (NSRL), and the Relativistic Heavy Ion Collider (RHIC). The Linac/Booster/AGS is utilized to produce or accelerate high-energy protons, polarized protons and the Tandem/Booster/AGS/RHIC is utilized to produce or accelerate heavy ions for use in various experiments developed to study the fundamental characteristics of matter. The AGS complex is composed of a ½-mile circumference accelerator ring, a smaller booster ring and a linear accelerator. Particles are accelerated within the AGS ring and then directed via one of the four primary beamlines to various experimental beamlines and targets. The NSRL, located north of the Booster, is used to supply ions ranging from protons up to gold for radiobiology and material studies by NASA. RHIC is a 2.4-mile circumference particle accelerator/collider. The RHIC facility consists of a beam injection system, two superconducting magnet beam storage rings, six experimental halls, and a number of support buildings. Accelerated protons, deuterons or heavy ions in counter-rotating beams, each in separate rings, may be brought into collision at six different locations where experiments are conducted. The particle cascade produced by the colliding beams will be recorded by various instruments to study nuclear phenomena in detail.

Water-cooled magnets are utilized to contain the protons and heavy ions in a circular orbit within the accelerator rings. Magnets are also utilized to direct the beam to the transfer lines and experimental beam lines. In order to prevent the magnets from overheating during operation, a closed-loop system is utilized to circulate cooling water through the magnets.

Over time, the bends of piping within the magnet cooling system become fouled or blocked with particulates (scale and/or silt). This prevents cooling water from circulating through the entire magnet as indicated by a rise in temperature. When a temperature rise is measured, the magnet is cleaned to remove particulates that block the magnet cooling system.

Sources of particulates in the cooling water include well water utilized for magnet cooling and old black iron cooling system pipes. The C-A Department is currently using potable water from the on-site Potable Water System that has already been filtered and treated to remove iron. In addition, many cooling water systems have dedicated make-up water and recirculating water deionization (DI) systems. These improvements to the magnet cooling water systems should have a significant impact in reducing magnet cooling-system fouling.

Magnet cleaning is performed using one of three techniques depending upon the severity of the fouling problem. All three magnet-cleaning techniques are performed while the magnet is in place. The three alternatives listed in the order in which they are undertaken are backwashing, flushing with compressed nitrogen and flushing with an acid solution.

The initial technique considered for removing blockages in the magnet cooling system is backwashing. Backwashing is conducted by reversing the inlet and outlet cooling water flow to the magnet, thereby circulating the cooling water in the opposite direction of normal flow. Particulates removed during backwashing become entrained within the cooling water and are removed by filters within the cooling water system.

If backwashing is unsuccessful at removing the blockages, compressed nitrogen may be used to flush the magnet cooling system. This technique involves blowing compressed nitrogen through the inlet or outlet of the magnet cooling system to remove particulates from the system. The turbulence in the cooling water caused by the compressed nitrogen dislodges the particulates built up in the piping bends and turns within the magnet cooling system. Dislodged particulates and displaced cooling water are collected in a drum. The drum contents are tested for radiological parameters and disposed of accordingly. If radioactive, the drummed water is disposed of off-site as liquid radioactive waste. If non-radioactive, the drummed water is returned to the magnet cooling water system.

C-A personnel indicate that backwashing and nitrogen flushing will clear the magnet cooling system of blockages the majority of the time. However, for the infrequent times when these techniques do not clear the magnet cooling system, an acid flush is utilized for magnet cleaning. The acid flushing operation is performed by two groups, the Mechanical Services Group and the Water Systems Group.

The acid flush operation uses an AC500 solution mixed in a 50/50 concentration with water. This mixture is circulated through the magnet for approximately 15 minutes utilizing a portable pump. Initially, 5 gallons is mixed and run through the magnet for five minutes. For each of the remaining five minute intervals an additional five gallons is mixed and run through the magnet. Following the 15 minute flushing period, the solution is drained from the magnet into appropriate containers and transported to either the 919 area High Bay (Water Systems Group) or to building 922 (Mechanical Services Group) where it is transferred into a 55 gallon drum and neutralized with sodium bicarbonate. C-A personnel indicated that approximately 3 to 4 magnets are flushed with this method during the course of a year and it produces approximately one 55-gallon drum of spent solution for disposal. The waste solution is tested for radiological parameters and if radioactive, disposed of off-site as liquid radioactive waste and if non-radioactive, it is disposed of as industrial waste.

<u>Regulatory Determination of Process Outputs</u>

1.0 Backwash

Backwashing involves reversing the flow of cooling water through the magnet to dislodge particulates from the piping bends and turns within the magnet cooling system. Hoses are attached to the magnet or cooling water manifold to reverse the water flow while in place. Particulates removed during backwashing become entrained within the cooling water and are removed by filters within the cooling water system. The hoses utilized during backwashing are reused.

No waste is generated by backwashing the magnet cooling system.

2.0 Nitrogen Flush

If backwashing is unsuccessful at removing blockages within the magnet cooling system, compressed nitrogen is utilized to flush water through the system. Compressed nitrogen gas is supplied in cylinders that are returned to the supplier when empty. Hoses are utilized to connect the nitrogen to the magnet cooling water outlet. A hose is connected to the cooling water inlet that empties into a drum. As nitrogen enters the magnet cooling system, the water is agitated and dislodges particulates in the system. Dislodged particulates and displaced cooling water are collected in the drum. If necessary, the magnet cooling system can be flushed additional times by adding water to the system and then repeating the procedure (and reversing the hoses if necessary). The drummed water is tested for radiological parameters and if radioactive, disposed of off-site as liquid radioactive waste. If non-radioactive, the drummed water is returned to the cooling water system. The hoses utilized during nitrogen flushing are reused.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
2.1	Nitrogen gas	Non-hazardous/non-radioactive gas as determined by process knowledge	Gas is directed into the drum and released to ambient air	None
2.2	Radioactive spent cooling water and particulates	Non-hazardous/ radioactive liquid waste as determined by radiological testing	Waste is transferred to WMD for processing and off-site disposal as radioactive waste	None

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
2.3	Non-radioactive spent cooling water and particulates	Non-hazardous/non-radioactive liquid waste as determined by radiological testing	Waste is returned to the magnet cooling water system	None
2.4	Empty nitrogen gas cylinders	Non-hazardous/non-radioactive material as determined by process knowledge	Empty cylinders are returned to the supplier	None

3.0 Acid Flush – Water Systems Group

The Water Systems Group will flush two to three magnets in the magnet cooling system annualy with an acid solution to remove particulates. This acid cleaning involves circulating a solution of AC500 through the magnet for a period of 15 minutes to remove particulates from the system. The acid solution is prepared by adding approximately 2.5 gallons of AC500 to 2.5 gallons of water. This step is repeated two additional times and produces approximately 15 gallons of solution in total. The solution is pumped through the magnet cooling system, collected in a drum and then recirculated through the system. Once completed, the acid solution is drained from the magnet cooling system and collected in an appropriate container. The spent solution is transferred to a 55 gallon drum in the 919 High Bay where it is neutralized using sodium bicarbonate and a sample is collected to test for hazardous and radiological parameters. If radioactive, the waste solution is sent to the Pump Room group who passes the solution through a bag filter and loads it into a tanker truck for off-site disposal as radioactive waste. If the waste solution is non-radioactive, it is sent to the Waste Management Division for disposal as industrial waste. The solids collected in the bag filter are screened for radioactivity prior to disposal. C-A personnel indicated that this waste is typically radioactive and disposed of as radioactive waste.

Waste ID	Waste Description	Determination/Basis	Waste Handling	Corrective Action Required
3.1	Radioactive spent acid solution and water (neutralized)	Non-hazardous/ radioactive liquid waste as determined by process knowledge/ radiological testing	Waste is loaded into a tanker truck and transferred off-site for disposal as radioactive waste	None
3.2	Bag filter solids	Non-hazardous/ radioactive solid waste as determined by process knowledge/ radiological testing	Waste is transferred off-site for disposal as radioactive waste	None
3.3	Non-radioactive spent acid solution and water (neutralized)	Industrial/non-radioactive liquid waste as determined by process knowledge/ radiological testing	Waste is transferred off-site for disposal as industrial waste	None

III. Waste Minimization, Opportunity for Pollution Prevention

During the initial effort of baselining the Collider-Accelerator Department processes for Pollution Prevention and Waste Minimization Opportunities each waste, effluent, and emission was evaluated to determine if there were opportunities to reduce either the volume or toxicity of the waste stream. Consideration was given to substitute raw materials with less toxic or less hazardous materials, process changes, reuse or recycling of materials and/or wastes, and other initiatives. These actions are documented in this section of the original process evaluation. Action taken on each of the Pollution Prevention and Waste Minimization items identified can be found in the Environmental Services Division's PEP 2000 Database. Further identification of Pollution Prevention and Waste Minimization Opportunities will be made during an annual assessment of C-A processes. If any Pollution Prevention and Waste Minimization Opportunities are identified they will be forwarded to the Environmental Services Division for tracking through the PEP Database.

IV. Assessment Prevention and Control

During the initial effort of baselining the Collider-Accelerator Department Assessment, Prevention, and Control (APC) Measures operations, experiments, and waste that have the potential for equipment malfunction, deterioration, or operator error, and discharges or emissions that may cause or lead to releases of hazardous waste or pollutants to the environment or that potentially pose a threat to human health or the environment were described. A thorough assessment of these operations was made to determine: if engineering controls were needed to control hazards; where documented standard operating procedures needed to be developed; where routine, objective, self-inspections by department supervision and trained staff needed to be conducted and documented; and where any other vulnerability needed to be further evaluated. These actions are documented in this section of the original process evaluation. Action taken on each of the Assessment, Prevention and Control Measures can be found in the Environmental Services Division's PEP 2000 Database. Further identification of Assessment, Prevention and Control Measures will be made during an annual assessment of C-A processes. If any Assessment, Prevention and Control Measures are identified they will be forwarded to the Environmental Services Division for tracking through the PEP Database.

ATTACHMENT 1

PROCESS FLOW DIAGRAM